S 878/US

TITLE OF THE INVENTION

SOLE FOR BOOT, IN PARTICULAR A SPORTS BOOT, A METHOD OF MANUFACTURING SAME, AND A BOOT HAVING SUCH A SOLE

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P21643

SOLE FOR A BOOT, IN PARTICULAR A SPORTS BOOT, A METHOD OF MANUFACTURING SAME, AND A BOOT HAVING SUCH A SOLE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon French Patent Application No. 00 15431, filed November 29, 2000, the disclosure of which is hereby incorporated by reference thereto in its entirety, and the priority of which is hereby claimed under 35 U.S.C. §119.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to the field of boots, in particular sports boots, and more particularly boots adapted to sports that require rolling/unrolling movements of the foot and/or to gliding sports involving supports of the same name, such as, but not limited to, cross-country skiing.

[0003] The invention also relates to gliding sports not involving rolling/unrolling movement of the foot, such as ice skating, roller skating, with or without in-line wheels, snowboarding, skateboarding, etc.

[0004] The present invention relates to a sole, especially an outer sole for a boot, for example a sports boot. This sole is of the type of those having a reinforcement or an insert made of a composite material adapted to provide rigidity in the transverse direction (high torsional stiffness), combined with a longitudinal flexibility, especially in the metatarsophalangeal zone (low longitudinal stiffness).

[0005] The invention also relates to methods of manufacturing the aforementioned soles via molding techniques.

[0006] Finally, the invention relates to a boot, especially a sports boot, provided with such a sole.

2. Description of Background and Relevant Information

[0007] Sports in which the foot and, therefore, the boot are subject to more or less pronounced rolling/unrolling movements are, for example, hiking, running, biking, cross-country skiing involving the evolutive technique so-called "alternate step" or "skating step", alpine skiing, telemark skiing, or snowshoeing, etc.

[0008] There are also gliding sports that do not involve rolling/unrolling movement of the foot, such as ice skating, roller skating, with or without in-line wheels, snowboarding, skateboarding, etc.

[0009] The aforementioned sports have common requirements with respect to the boot, and especially to the sole, which requirements are, at the outset, incompatible.

[0010] In fact, all of the aforementioned sports generally require a shifting of the user's center of gravity from the heel zone of the foot to the so-called metatarsophalangeal area of natural bending of the foot, and vice versa. These shiftings serve to direct and/or propel the user's body, for example, by means of edge setting or equivalent maneuvers, such as the movement impulse performed by striding with a roller skate, or a cross-country ski, whether with the conventional technique or the skating technique. These shiftings of the center of gravity are accompanied

by a transmission of forces in the heel zone, on the one hand and, in some cases, by a bending in the metatarsophalangeal bending zone, on the other hand.

[0011] This generates the requirement for a good transmission of the forces, without any losses by shock absorption and undesirable deformation in the area between at least the heel and the metatarsophalangeal zone and, consequently, a requirement for rigidity of the sole in this zone, often accompanied by a requirement for as natural a rolling/unrolling movement as possible and, therefore, for flexibility of the sole in the metatarsophalangeal zone, so that it can bend easily with respect to the metatarsophalangeal joint. This joint can be defined as being that whose axis forms an angle of about 71° with the internal tangent of the foot, and crosses the longitudinal median axis at about 73% of the total length of the foot, from the heel.

[0012] It is obvious that the integration of two different, and even incompatible requirements in one element, i.e., the sole, generally can only be performed to the detriment of one of these requirements, i.e., the transmission of the forces coming from the leg in the zone comprised between the heel and the metatarsophalangeal zone and/or the flexibility in the latter zone.

[0013] The resulting problem is that, generally, this construction of the sole cannot meet all of the requirements at the same time, and it usually represents a more or less satisfactory compromise between rigidity and flexibility.

[0014] Another problem concerns the manufacture of the soles of the aforementioned type in one piece. These soles entail high manufacturing costs, because it is necessary to provide soles of specific and various lengths for all the desired sizes. This results in a necessity of manufacturing and storing a large number of different soles, and of cutting the edges of a sole to obtain a smaller size. This

latter technique, which is only used for the wear soles, is a waste of material and burdens the production costs.

[0015] In addition to the mechanical characteristics of torsional stiffness in the rear portion and of flexibility in longitudinal bending along the metatarsophalangeal axis, other parameters must be taken into consideration, including, in particular, lightness, cost, industrial workability, and durability.

[0016] It is known to use upper/vamp or sole reinforcements in an attempt to control rigidity and bending. A certain number of prior technical propositions exist, but none is entirely satisfactory.

[0017] The patent document No. EP 0 931 470 describes a sports boot including a stiffening element integrated into the lower portion (sole unit of the boot). This stiffening element is an insole or an outsole or a sandwich-type internal reinforcement including an inner layer 15 made of expanded plastic foam (made of light wood, touching plastic cylinders, cellular or honeycombed core), this core being inserted between two layers 13 and 14 based on polymer (nylon, polyurethane, polypropylene), resin or composite material including synthetic resins in which carbon, aramide or glass fibers are inserted. The rigidity of the layers 13 and 14 is greater than that of the inner layer 15. The thickness of the latter is greater than that of the layers 13 and 14. It is apparent from FIG. 5 and the text, column 3, lines 41-53, of EP 0 931 470 that the stiffening element can include portions of variable cross-section and different flexibilities, in particular having greater longitudinal flexibility at the forefoot.

[0018] The sandwich reinforcement according to EP 0 931 470 is adapted to provide rigidity to the sole unit so as to render it rigid, or at least semi-rigid. The target applications are mountain boots, cycling shoes, and roller skate boots. In all

these applications, it is clear that one is not looking for a longitudinal flexibility in the metatarsophalangeal area which would enable rolling/unrolling movements with respect to the front tip of the foot. In addition, this stiffening element complicates the manufacture and appears to be perfectible with respect to its mechanical properties.

[0019] The French Patent Publication No. 2 600 868 (based upon Application No. 86 10130) relates to a sole for a cross-country ski boot, which is stiff in torsion and flexible in the longitudinal direction. This sole includes a reinforcement located at least in the metatarsophalangeal zone and corresponding to an insole constituted by a composite sheet (glass, carbon or aramide fibers embedded in epoxy or polyester resins). This composite sheet has the characteristic of having fibers that are oriented in two or three directions with respect to the longitudinal axis of the sole (multidirectional fabric). This is supposed to enable desired stiffnesses to be obtained in the longitudinal transverse direction or in torsion. Furthermore, this boot sole does not have optimum qualities with respect to transverse rigidity, therefore with respect to the steering of the ski, flexibility, durability, lightness, efficiency, uniformity and sensitivity of the rolling/unrolling movement, and with respect to the protection of the foot during bendings.

[0020] The French Patent Publication No. 2 682 011 (based upon Application No. 91 12376) relates to a cross-country ski boot whose torsional stiffness and longitudinal flexibility in the metatarsophalangeal zone are improved, and which has an outer sole covered by an insole defining therebetween a peripheral assembly zone, so-called lasting allowance, which makes it possible to affix the upper and the vamp to the lower portion of the boot. The outer sole has properties of torsional rigidity, and it is mounted in combination with the insole made of a flexionally flexible material (rubber) in a zone corresponding to the front portion of the foot. Furthermore, the insole is made of leather or cellulose fibers in its front end area

corresponding to the zone of the toe bones, while the rear portion is made, for example, of cardboard.

[0021] In this boot, the torsional stiffness in the zone of the metatarsophalangeal bending axis and, therefore, the control of the ski remain perfectible.

[0022] Furthermore, this boot could also be improved with respect to optimizing its efficiency, which results from the spring effect in this zone of the metatarsophalangeal bending axis.

[0023] Finally, the materials used in the insole of this boot do not offer all the desired guarantees in terms of stability of the mechanical properties over time.

[0024] The prior art also includes a certain number of references that are directed more specifically to soles, and which will be addressed hereinafter.

[0025] U.S. Patent No. 2,581,524 proposes to manufacture a two-part midsole. However, this sole is adapted to a boot for spare-time activities and, consequently, the rear portion remains flexible, although it has a higher rigidity with respect to the front portion. The flexibility and a certain shock-absorption of the rear portion are obtained by making it out of materials such a cork, sawdust, or latex. Therefore, the known sole of this document is not capable of transmitting forces intended for edge setting, for example, and therefore does not provide a satisfactory solution to the problems described hereinabove.

[0026] The same is true with the teachings of the U.S. Patent Nos. 1,428,356 and 3,984,925.

[0027] The French Patent Publication No. 2 743 989 relates to a sole, especially for a boot adapted to sports requiring an unrolling movement of the foot, or to gliding sports. This document describes an outer sole constituted of a front portion and a rear portion. The rear portion covers at least the base of the heel and extends up to the metatarsophalangeal bending zone. It is rigid and substantially non-flexible. The front portion is flexible and has, at its end corresponding to the end of the foot, at least one member for coupling to a gliding support such as a cross-country ski. The adjacent front and rear portions overlap one another in the junction zone where they are assembled by cementing or riveting. In the junction or assembly zone, the end involved of the front portion is overlapped by the corresponding end of the rear portion. A stiffener of the upper can be affixedly attached on the rear portion.

[0028] It appears that such a sole can still be improved with respect to torsional rigidity and the possibility to bend in the area of the metatarsophalangeal joint.

[0029] The German Patent Publication No. 41 20 136 relates to a boot sole, especially a sports boot sole, which is sufficiently flexible in the area of the forefoot in order not to hinder the rolling/unrolling movements of the foot, on the one hand, and which is sufficiently rigid, especially in torsion in the journal zone and in the rear portion, on the other hand. This sports boot sole has a composite material (matrix + woven or nonwoven fibers) in which the continuous fibers are oriented in several directions. This composite material is enclosed in a sole body arranged on the edges of the sole, made of thermoplastic or elastomeric material and affixedly attached to the composite material by welding or chemical bonding, or even by (duplicate) molding. As shown in FIGS. 1 and 2, the sole can have two composite plates 71a, 71b located in the front portion and in the rear portion, respectively. These two composite plates 71a and 71b are housed and fixed in a sole body forming a frame and including a transverse bridge 72 separating the two plates 71a and 71b.

[0030] As shown in FIG. 6, this sole can include a single element, or composite plate 171 extending along the entire length and ensuring a transverse rigidity. In this embodiment, the rear portion has a second composite plate 67 having a longitudinal, diagonal or isotropic rigidity. Also provided is a layer 68 made of rubber, inserted between the composite plates 171 and 67 in the rear portion.

[0031] It must be noted that the peripheral sole body forming a frame in which the composite plate or plates are housed and fixed is integral. Therefore, here is a problem related to the industrial manufacture of the soles in one piece for several sizes. The drawbacks associated with this problem, both economical and in terms of workability, have been presented hereinabove.

[0032] Moreover, this type of known sole does not offer the possibility of providing projecting elements on the lower surface of the sole, such as guiding central grooves or wear resisting adherence pads.

[0033] Furthermore, the sole according to DE 41 20 136 includes a relatively large number of elements, which complicates the industrial manufacture thereof.

[0034] Finally, the mechanical characteristics (optimizing efficiency, elasticity, resistance) weight, durability, are not optimized.

[0035] Therefore, one has to establish that the prior technical propositions are not entirely satisfactory, or are ill-adapted to solving the overall technical problem consisting of:

- increasing the torsional stiffness:

  • so as to improve the steering and the control of the sports apparatus, especially gliding apparatus (e.g., ski), while optimizing the bending ability in the metatarsophalangeal zone; and

so as to enable the foot to perceive the reactions of the terrain and of the apparatus;

- optimizing the flexional flexibility, so as to enable a uniform and easy rolling/unrolling movement of the foot;

- improving the efficiency of the boot by optimizing the spring effect in the metatarsophalangeal zone, without hindering the flexibility and torsional stiffness;

- using materials meeting the mechanical requirements mentioned hereinabove, and capable of maintaining these mechanical qualities over a long period of time;

- further lightening the weight on the boot;

- protecting the foot during bendings by minimizing the compressive stress to which the foot is subject;

- maintaining the production cost within acceptable limits;

- ensuring industrial workability;

- developing a reinforcement that can be easily manufactured industrially.

SUMMARY OF THE INVENTION

[0036] One of the objects of the present invention is to provide a boot sole, especially a sports boot sole (e.g., cross-country ski boot), which procures significant advances, in particular with respect the aforementioned technical specifications.

[0037] Another object of the invention is to propose a sole for a cross-country ski boot which makes it possible to improve the efficiency, steering of the ski, durability, while conserving or gaining flexibility, weight loss, cost, foot protection, and industrial workability.

[0038] Another object of the present invention is to provide a boot, especially a sports boot, and more specifically a cross-country ski boot, having a reinforcement in the bottom assembly that is capable of meeting the aforementioned working specifications as much as possible.

[0039] Another object of the invention is to provide a sole, in particular an outer sole for a boot, especially a sports boot, which is lightweight, requires a small quantity of plastic material, and which makes it possible to replace, or even eliminate the conventional insole.

[0040] Another object of the invention is to provide a sole for a boot, especially a sports boot, having a structure such that it is possible to vary the mechanical characteristics in a wide range, without unduly complicating the manufacturing process.

[0041] Another object of the invention is to propose a manufacturing method for the aforementioned sole, as well as a boot provided with such a sole.

[0042] Another object of the invention is to propose a method of manufacturing a boot provided with such a sole.

[0043] To achieve these objects, among other things, credit goes to the inventors for finding a sole that is flexible at the front and rigid at the rear due to a reinforcement (for example, a composite reinforcement that is cemented or duplicate molded), this reinforcement being assembled with two front and rear half-soles affixedly attached to one another.

[0044] Therefore, the present invention relates primarily to a sole for a boot, especially a sports boot:

- having a front portion, and a rear portion that is more rigid in longitudinal bending than the front portion,

- including at least one reinforcement in these two portions,

- wherein:

• the front portion has a front half-sole affixed to the reinforcement,

• the rear portion has a rear half-sole affixed to the reinforcement; and

• the front and rear half-soles are assembled to one another in a junction zone, preferably, by cementing and/or riveting and/or welding.

[0045] According to the invention, the construction of the sole around the reinforcement (which can also be called a core or an insert), by providing two distinct half-soles for the front and the rear (preferably duplicate molded at the front), with an assembly affixed to these two half-soles in a junction zone, contributes to achieving the desired results in terms of longitudinal flexibility and torsional rigidity in the front portion, and of longitudinal and torsional stiffness in the rear portion. The same is true with respect to:

- the efficiency of the boot (spring effect at the front);

- the steering of a sports apparatus (for example a gliding support) possibly coupled to the boot sole;

- durability;

- lightness;

- ease;

- the precision of the rolling/unrolling movement of the foot and of the boot;

- the perception of the sensations coming from the reactions of the terrain and of the apparatus; and

- the protection of the foot during bendings.

[0046] The rigidity and the non-flexibility at the rear enable an efficient transmission of the forces coming from the user's leg, which are adapted to direct or propel the user's body, especially by enabling an efficient edge setting, or to cooperate with a guiding system of the ridge-type in cross-country skiing.

[0047] Preferably, the limit between the front portion, substantially flexible in the longitudinal direction and stiff in torsion, and the rear portion, rigid in torsion and in the longitudinal direction, is located substantially at the rear of the so-called metatarsophalangeal bending area.

[0048] According to another preferred characteristic of the invention, the two front and rear half-soles overlap one another in the junction zone, and the length of the junction zone is adjustable depending on the size.

[0049] The length of this junction zone is adjustable within certain limits depending on the size. The variation in the overlapping length allows for the manufacture of soles of various sizes on the base of the identical rear and front portions, respectively, which considerably reduces the production and storage costs through the diminution of the number of various parts to be manufactured. This construction also provides a better precision in manufacturing and adjusting the soles to the boots.

[0050] Clearly, there is a limit to the variation in the overlapping length L (L1, L2). This limit is due to the length of the reinforcement (for example, composite reinforcement) in relation to the total length of the sole, but more so to the length of the half-soles.

[0051] According to a remarkable characteristic of the invention, the rear half-sole overlaps the front half-sole in the junction zone.

[0052] Thus, seen from the bottom, the front end zone of the rear half-sole is located above and covers the rear end zone of the front half-sole.

[0053] Advantageously, the assembly between the front half-sole and the rear half-sole is obtained in this junction/overlapping zone.

[0054] Preferably, the latter is located in and/or behind the so-called metatarsophalangeal bending zone.

[0055] Such a construction enables a significant weight loss while guaranteeing the desired mechanical characteristics due to the reinforcement. Thus, there are less compressive stresses on the reinforcement compared to the known embodiments as described, for example, in EP 0 931 470, in which the reinforcement is used as an insole, or as an insole reinforcement.

[0056] The fact that the rear half-sole, in a bottom view, overlaps the front half-sole in the junction/assembly zone, precisely ensures a better assembly and makes it possible to prevent incipient separations of the rear end zone from the front half-sole which bends, since the latter is sandwiched between the reinforcement and the rigid rear half-sole which does not bend.

BRIEF DESCRIPTION OF DRAWINGS

[0057] The invention will be better understood and other characteristics thereof will become apparent from the description that follows, with reference to the annexed schematic drawings showing, by way of non-limiting examples, a plurality of embodiments, and in which:

[0058] FIG. 1 is a bottom view of a sole according the present invention;

[0059] FIG. 2 shows a straight transverse cross-section along the line II-II of FIG. 1;

[0060] FIG. 3 is a side view of a sole according to a second embodiment of the present invention;

[0061] FIGS. 4a and 4b are side views of a sole according to the preferred embodiment of the invention as shown in FIGS. 1 and 2;

[0062] FIG. 5 is a bottom view of an intermediate piece for manufacturing the sole according to the invention (third embodiment) including the reinforcement on the front area of which the front half-sole is duplicate molded; and

[0063] FIG. 6 is a lateral view of a boot incorporating a sole according to the invention (fourth embodiment) as well as a stiffener.

DETAILED DESCRIPTION OF THE INVENTION

[0064] FIGS. 1, 2, 4a, 4b correspond to the preferred embodiment of the sole according to the invention.

[0065] In the non-limiting example described here, the sole according to the invention is an outer sole for a cross-country ski boot, this sole being generally designated by the reference numeral 1. As shown in the figures, this sole includes a reinforcement 2, preferably made of a composite material, which, in this case, is made in the form of an insert included in two front and rear half-soles designated by the reference numerals 3 and 4, respectively. The front half-sole 3 and the rear half-

sole 4 are integral with, and can be unitary with, the front portion and the rear portion, respectively, of the sole 1.

[0066] The front half-sole 3 and the rear half-sole 4 are assembled to one another in a junction zone L, L1, L2, L3 in FIGS. 3, 4a, 4b, 6, respectively, along a contact plane that can be substantially perpendicular (FIG. 3: 2nd embodiment) to the plane of the sole, or which forms, with the latter, an angle less than 90°, preferably less than or equal to 45° (FIGS. 4a, 4b, 6: preferred embodiment and 4th embodiment).

[0067] The assembly of the half-soles 3, 4 along this contact plane is obtained by any appropriate means known to a person with ordinary skill in the art, for example, by welding and/or cementing and/or riveting.

[0068] In the preferred embodiment and the fourth embodiment shown in FIGS. 1, 4a, 4b, and 6, this junction zone corresponds to the intermediate area of the sole 1 in which, above and beneath the reinforcement 2, at least a portion of the front end zone 5 of the rear half-sole 4, in a bottom view, overlaps (or covers) the rear end zone 6 of the front half-sole 3. This appears clearly in FIGS. 4a, 4b, and 6 in which the junction/overlapping zones are designated by the references L1, L2, L3.

[0069] As shown in FIGS. 1, 4a, 4b, and 6, the rear end zone 6 of the front half-sole 3 is beveled and covered (in a bottom view) by the front end zone 5, also beveled, of the rear half-sole 4, beneath the reinforcement 2.

[0070] According to the invention, each front 3 or rear 4 half-sole includes the constituent material located beneath the reinforcement 2, which material may or may not extend above the reinforcement 2.

[0071] In the preferred embodiment of the sole shown in FIGS. 1 and 2, the front half-sole 3 at least partially encloses the front of the reinforcement 2, such that the constituent material of the front half-sole 3 is present beneath and above the reinforcement 2. On the other hand, the rear half-sole 4 does not, or virtually does not overlap above the rear of the reinforcement 2.

[0072] It is different with the embodiments shown in FIGS. 3, 4a, 4b, and 6, according to which the reinforcement 2 is included in the two front 3 and rear 4 half-soles, such that the constituent material of these half-soles is present beneath and above the reinforcement 2.

[0073] With respect to the reinforcement 2, it is preferably constituted by at least one laminated or non-laminated plate extending from the junction zone, both on at least half of the front portion and on at least half of the rear portion.

[0074] Advantageously, the reinforcement 2 has a length corresponding substantially to at least 60%, preferably at least 70%, and even more preferably at least 80%, of the length of the sole.

[0075] It is also preferable that the composite plate 2 forming the reinforcement have a form corresponding substantially to the form of the projection, on a plane, of a human foot placed on this plane of projection. In practice, the total length of the plate 2 corresponds substantially to 90% of the total length of the sole 1.

[0076] According to one advantageous embodiment of the invention, at least one of these front 3 or rear 4 portions is designed to cooperate with a sports apparatus.

[0077] In practice, it is naturally the lower surface of the sole 1, or more precisely of the front 3 and/or rear 4 half-sole that has a form and means provided to cooperate with a sports apparatus, for example a cross-country ski. Thus, the half-sole or half-soles 3, 4 themselves can be constituted by at least one piece 8, 8a, 9_3, 9_4, 13 for guiding and/or for connecting to a sports apparatus.

[0078] The result is that, according to an advantageous alternative embodiment of the invention, the sole 1 has, on its lower surface, in the front portion and/or rear portion:

- at least one guiding member 8, 9_3, 9_4, adapted to cooperate with complementarily shaped guiding means provided on a sports apparatus, preferably a gliding support (for example a cross-country ski), to which the sole 1 is designed to be coupled; and
- possibly, at least one adherent and wear resisting pad 8a.

[0079] In addition, according to another interesting alternative embodiment of the invention, the sole 1, in particular the front portion, includes at least one member 13 for coupling to a sports apparatus, preferably a gliding support (for example a cross-country ski).

[0080] According to an embodiment of the invention, at least one of the front 3 and rear 4 half-soles (preferably the front half-sole) is duplicate molded, co-molded, on the reinforcement 2, this duplicate molding being preferably selected from the moldable plastic materials, reinforced or non-reinforced, and having appropriate mechanical qualities for rigidity in the rear portion and flexibility in the front portion.

[0081] Still preferably, the front half-sole 3 is duplicate molded on the front of the reinforcement 2 (FIG. 5) and the rear half-sole 4 is cemented on the rear of the reinforcement 2.

[0082] However, it is also possible for the reinforcement to be assembled on the two half-soles by other assembly techniques, such as cementing or riveting.

[0083] The type of constituent matrix material(s) of the front half-sole 3 and of the rear half-sole 4 assembled to one another in the junction/overlapping zone (L, L1, L2, L3) will be discussed in more detail hereinafter.

[0084] Advantageously, the reinforcement 2 is made of a composite material. Thus, it can be constituted of a matrix (for example a thermoplastic or thermosetting resin) in which short or long reinforcing fibers are embedded. The reinforcement 2 can also be made in the form of a composite laminate including one or several textile layers, woven or nonwoven, which are coated and embedded in a preferably thermosetting matrix, such as polyester or epoxy resins. The textile fibers used are, for example, glass, carbon, or polyaramide fibers.

[0085] According to an improved embodiment, the reinforcement 2 is formed by a plate having a sandwich-type structure including a core inserted between two single or multi layered laminas. In the case where the sandwich structure has a thickness less than or equal to 3 mm, it is referred to as a "microsandwich," such a "microsandwich" structure being preferably provided in the rear portion.

[0086] The "sandwich" structures are known in the field of composite materials. Conventionally, at least one of the laminas (preferably both) of the "sandwich" structures is made of composite based on woven or non-woven fibers included in a matrix.

[0087] The outer laminas are constituted by a material selected from the following group of composites:

- the composites:

• whose matrix is made of thermosetting polymer resin such as epoxy resins, phenolic resins, polyester resins, and their mixtures; and

• whose woven or nonwoven fibrous material includes polyethylene fibers, glass fibers, carbon fibers, polyaramide fibers (poly-paraphenylene-terephthalamide: KEVLAR®), metallic fibers, polyethylene fibers, natural or synthetic textile fibers and their mixtures; the carbon and glass fibers being more particularly preferred;

- the composites:

• whose polymeric matrix is made of thermoplastic polymer, advantageously made of polyamide, polyurethane, polyolefine, or polyacrilobutadiene styrene (ABS), and their mixtures; and

• whose woven or nonwoven fibrous material includes glass fibers, carbon fibers, poly-paraphenylene-terephthalamide fibers (KEVLAR®), metallic fibers, natural or synthetic textile fibers and their mixtures; the carbon and glass fibers being more particularly preferred;

- the composite laminates constituted at least partially by one or several microsandwich composite sheets each having a thickness less than or equal to 3 mm and including a core inserted between at least two composite laminas.

[0088] By way of examples of fibers that can be used in these composites, one can cite those provided in the table below, which mentions the type of weaving laps and the mechanical characteristics of these networks or fibrous laps.

Fibers	Weaving	Breaking Stress greater than	Modulus greater than
Glass	Unidirectional	700 MPa	25000 MPa
Glass	Multidirectional	350 MPa	12000 MPa
Carbon	Unidirectional	1500 MPa	70000 MPa
Carbon	Multidirectional	700 MPa	35000 MPa

[0089] Advantageously, the core of the sandwich structure is made of synthetic foam, preferably polyurethane, polymethacrylate, polyvinyl chloride, of wood or honeycomb, cellular cores. In the case of "microsandwich" structures, the core can be a composite structure having lower mechanical characteristics and/or cost than those of the laminas. Thus, composite structures having paper or silk embedded in a matrix can be used.

[0090] In addition to the composites, the reinforcement 2 can be made of any appropriate material, for example, wood, metal (steel), thermoplastic polymer.

[0091] According to an advantageous alternative embodiment of the invention, the reinforcement 2 (composite or non-composite) is a plate covered, at least on one of its surfaces, with at least one compatibility layer adapted to promote compatibility between the reinforcement 2 and the half-sole(s) 3 and 4, preferably duplicate molded plastic(s), or between the reinforcement 2 and the boot upper, or yet between the (composite or non-composite) reinforcement 2 and the rear half-sole. This layer is advantageously constituted by at least one synthetic film forming polymer, especially selected from the group including polyamides and/or polyolefines and/or polyurethanes.

[0092] According to yet other alternative embodiments, the reinforcement 2 can be composed of a plurality of composite plates or layers at least partially superimposed or non-superimposed.

[0093] The reinforcement 2 (e.g., composite reinforcement), in this case the plate, can also be envisioned not to have the shape of the foot and to occupy a markedly smaller surface than that corresponding to the preferred embodiment (namely 90% of the surface of the sole).

[0094] Furthermore, the reinforcement 2 could be formed of a plurality of elements that are not in the form of plates.

[0095] In one embodiment, the reinforcement 2 is made of a single-layer type composite formed by an epoxy matrix reinforced by woven carbon fibers.

[0096] The front 3 and rear 4 half-soles will be discussed in more detail hereinafter.

[0097] As indicated hereinabove, the front and rear half-soles 3, 4 in the preferred embodiment have, on their lower surface, guiding blocks or ribs 8 that define a guiding groove 9_3, 9_4 along the longitudinal axis β of the sole 1. A portion 9_3 of this guiding groove 9 is arranged in the front portion, on the front half-sole 3, and another portion 9_4 of this groove 9 is located in the rear portion, on the rear half-sole 4.

[0098] This guiding groove 9_3, 9_4 is adapted to cooperate with a complementarily shaped rib provided on a gliding support, namely a cross-country ski in this case.

[0099] In this case, these guiding blocks or ribs 8 are constituted by some types of beams in the longitudinal direction and adapted to cooperate with a correspondingly shaped guiding edge of the binding.

[0100] In addition to the fact that they define the guiding groove 9_3, 9_4, these blocks or ribs 8 have the function of improving the adherence of the boot sole on the support with which it cooperates, due to the anti-slip pad 8a with which each is provided. They also have the role of providing the sole with wear resistance properties, and more particularly resistance to abrasion.

[0101] It must also be noted that the longitudinal median axis (M) of the front portion forms an angle with the longitudinal median axis (M') of the rear portion (FIG. 1).

[0102] This FIG. 1 also shows the axis Δ of the metatarsophalangeal joint which corresponds substantially to the bending axis of the front portion of the sole 1. This axis Δ forms an angle α on the order of 70° with respect to the internal tangent of the sole. In addition, this axis Δ intersects with the longitudinal median axis at a point located at about 73% of the total length of the sole 1 along the axis β and from the heel.

[0103] On their upper surface, the front 3 and rear 4 half-soles have a peripheral edge 10 (duplicate molding) on at least a portion of the periphery of the sole 1, in this case on the entire periphery. This peripheral edge or cementing board 10 is adapted to enable a good assembly, for example by cementing, of the outer sole 1 with the upper/vamp 11 shown in FIG. 6. This cementing board 10 is designed such that it makes it possible to compensate for the imperfections of the upper/vamp 11, namely roughing, fold, stiffener, for example.

[0104] According to another advantageous embodiment of the invention, the sole 1 includes one or several recesses 12 provided at least in its lower surface and showing a portion of the preferably composite reinforcement 2.

[0105] Furthermore, the drawings also show that the front half-sole 3 has at least one element 13 for coupling to a gliding support, for example a cross-country ski. In the present example, it is a transverse metallic cylindrical rod, perpendicular to the axis β and affixedly fixed by its two ends to the inner flanks of the two guiding blocks or ribs 8, in the vicinity of the front end of the sole 1.

[0106] In the embodiment shown in FIG. 5, two coupling elements 13 are provided.

[0107] The assembly between the front 3 and rear 4 half-soles in the junction zone L is done with overlapping (FIGS. 1, 4a, 4b, 6) or without overlapping along a plane substantially perpendicular to the plane of the sole (FIG. 3). This assembly is obtained by any known and appropriate means, such as heat bonding, cementing, or riveting, for example.

[0108] The extreme front limit of the overlapping zone L, L1, L2 is advantageously constituted by the axis Δ of the metatarsophalangeal joint. For reasons related to progressiveness and comfort, and to ensure a better rolling/unrolling movement of the foot, without rupture, the junction/overlapping zone L, L1, L2 preferably has a rigidity comprised between that of the rear portion and of the front portion, or even a rigidity that diminishes progressively from its zone of junction with the rear portion, up to its zone of junction with the front portion for a perfect transition with these two extreme rigidities.

[0109] As shown in FIGS. 4a and 4b, it is possible, in the case of an overlapping of the front 6 and rear 5 ends of the half-soles 3, 4, respectively, to vary the length L, L1, L2, L3 of the junction/overlapping zone by modifying the degree of overlapping. In FIG. 4a, the sole has a junction zone having a length L1, and in FIG. 4b, the latter has a shorter length L2, such that the total length P1 of the sole 1 of FIG. 4a is shorter than the total length P2 (size) of the sole 1 of FIG. 4b. The variation margin is comprised, for example, between 14 and 21 mm. This makes it possible to cover two to three boot sizes, with a single size of the front 3 and rear 4 portions, with a reinforcement 2 of a given length, and without significantly modifying the manufacturing parameters, which will be developed hereinafter.

[0110] According to an alternative, the reinforcement 2 has, in the rear portion of the sole, one or several upward extensions (at the level of the heel, for example) to increase the torsional rigidity.

[0111] According to another alternative, whether or not cumulative with the above-mentioned alternative, this reinforcement 2 can be associated with at least one other reinforcement, preferably at the rear, in order to increase the rigidity of this portion.

[0112] It can also be envisioned that the reinforcement 2 have longitudinal corrugations, at least in the metatarsophalangeal bending zone, to increase the torsional stiffness, without increasing the flexional stiffness.

[0113] The rear half-sole 4 is preferably rigid and substantially non-flexible so as to avoid losses of energy by shock-absorption and parasitic deformation, which enables a better transmission of forces. To this end, the matrix material selected is advantageously constituted by a plastic material (thermoplastic) with appropriate rigidity, possibly reinforced by glass or carbon fibers or a metallic material. By way

of examples of matrix plastic materials for the rear portion, one can cite: polyamides (ZITEL™), polyurethanes, polyacetates, polyoxymethylene, polycarbonates, polyether block amide. In any event, the materials of the rear portion and of the composite reinforcement are selected such that this rear portion preferably has a modulus of elasticity comprised between 260 MPa and 200 000 MPa.

[0114] The front half-sole 3 is flexible to enable the rolling/unrolling movements of the foot as naturally as possible. The material(s) used for the front matrix assembly 3 are therefore selected by taking into account the mechanical qualities specific to the composite reinforcement 2 in the front portion. For example, these are plastic materials (thermoplastics) that are suited for the molding techniques. By way of examples of such plastic materials, one can cite: polyether block amides (Pebax™), polyamides, polyurethanes, polyacetates, polyoxymethylene, polycarbonates.

[0115] It is clear that each front 3 or rear 4 half-sole can be constituted of several different materials. In this case, the adherence and wear resisting pads 8a are constituted of a material distinct from the remainder of the half-sole. For example, it can be elastomers [such as rubber, styrene-butadiene: "Styrene-Butadiene Rubber" (SBR)], thermoplastic elastomers [such as "thermoplastic-rubber"], or thermoplastics [such as polyurethane (PU), polyethylene butadiene (PEBA), polyamide (PA)].

[0116] FIG. 5 shows an intermediate piece 15 for manufacturing the sole 1 according to the invention. This intermediate piece only includes the front half-sole 3, to which the reinforcement 2 is assembled. In the embodiment shown, this assembly is ensured by duplicate molding the front half-sole around the front portion of the reinforcement 2. The reinforcement formed by a composite plate 2 having perforations 7 for enabling the passage of bridges of duplicate molding plastic material(s) forming the front 3 and rear 4 half-sole or half-soles and connecting the

portions of the half-sole or half-soles located above and beneath the reinforcement 2. The purpose of these perforations 7 is to ensure that, in obtaining the sole by duplicate molding of the composite reinforcement 2 with plastic matrix material, the latter extends through the composite reinforcement. This makes it possible to improve the mechanical fixing of the duplicate molded half-sole or half-soles 3, 4 on the composite reinforcement 2. In this case, this intermediate piece only includes the composite reinforcement 2 with perforations 7, which composite reinforcement is duplicate molded by the front matrix assembly 3 which has guiding blocks 8, a groove 9_3 and transverse rods 13 for coupling to the cross-country ski.

[0117] Advantageously, the transverse metallic rods 13, used as coupling members, are affixed to the front matrix assembly 3, in the area of the tip of the sole 1, during duplicate molding.

[0118] FIG. 6 shows a boot having an outer sole 1 according to a fourth embodiment of the invention. This sole is affixed to an upper/vamp 11, and has a stiffener 14 in its rear portion.

[0119] This rear portion forms an integral or unitary assembly with the stiffener 14 which covers the heel, the rear portion preferably having a different, and even more preferably greater rigidity than that of the stiffener 14.

[0120] This stiffener 14 surrounds the heel of the foot in the manner of a shell. Preferably, the stiffener 14 extends from the heel zone up to the metatarsophalangeal natural bending zone L3. The effect of holding the heel of the foot, in the manner of a shell, by the integral assembly formed by the rear portion of the sole 1 and the stiffener 14, is markedly improved when the stiffener 14 is substantially rigid and has a rigidity similar to that of the sole. Preferably, the rigidity of the stiffener 14 is lower than the rigidity of the rear portion of the non-flexible sole 1. The choice

of rigidity for the stiffener 14, the portion and the rear half-sole 4 of the sole 1, respectively, can be done optimally by selecting or not selecting a same material for these three elements, while keeping the integral assembly. The preferred materials for the stiffener 14 are leather or plastic materials possibly reinforced by inserts made of metallic material or glass or carbon fibers.

[0121] According to an advantageous characteristic of the invention, the front half-sole 3, the rear half-sole 4, the reinforcement 2, and possibly the stiffener 14 (FIG. 6), are made of different materials.

[0122] Advantageously, the stiffener 14 could be associated with possible upward extensions (or lateral extensions) mentioned hereinabove and not shown in the drawings. These two elements could thus cooperate to provide more torsional rigidity.

[0123] According to another one of its aspects, the present invention relates to a method for manufacturing the sole 1 according to the invention as defined hereinabove.

[0124] Advantageously, this method essentially comprises:

(1) using a plate 2 adapted to be the reinforcement of the sole 1 and having a form corresponding substantially to the form of the projection, on a plane, of a human foot placed on this plane;

(2) assembling (by cementing, riveting, or duplicate molding) the reinforcement 2 to a front half-sole 3 to obtain an intermediate piece.

[0125] When the assembly is made by duplicate molding, the assembly step comprises:

(a) placing this reinforcement 2 in a mold whose cavity corresponds to the form of the front 3 and/or rear 4 (preferably front) half-sole of the sole 1;

(b) possibly placing in the mold at least one element 13 for coupling to a sports apparatus, preferably a gliding support;

(c) duplicate molding the reinforcement 2 by means of identical or different material(s), preferably different materials at least for the front half-sole 3 and the rear half-sole 4;

(d) extracting from the mold the intermediate piece 15 formed by the reinforcement 2 on which the front half-sole 3 (or the rear half-sole 4) is duplicate molded.

[0126] Subsequent to the process, the rear half-sole 4 (or the front half-sole 3) is fixed on the intermediate piece 15, for example, by cementing.

[0127] FIG. 5 shows the intermediate piece 15 as obtained in the preferred embodiment described hereinabove.

[0128] According to an alternative corresponding to the making of the two half-soles 3 and 4 by duplicate molding, in two distinct, successive molding operations:

- this intermediate piece 15 is placed in a mold of the rear half-sole 4 (or front half-sole 3) according to a step a';
- the rear half-sole 4 (or front half-sole 3) is duplicate molded according to a step b';
- the sole including the duplicate molded reinforcement 2 is extracted from the mold.

[0129] According to an alternative of the method according to the invention leading to the sole of the boot of FIG. 6, a stiffener 14 is affixedly fixed to the rear matrix assembly of the sole 1, such that they form an integral or unitary assembly.

[0130] Due to its design and particularly to its manufacture, at least partially, by duplicate molding:

- the sole according to the invention has thin layers of plastic material, such that the plastic matrix is less sensitive to aging with respect to the mechanical properties;

- it can be envisioned to use a single mold for the sole to obtain variable mechanical characteristics by merely duplicate molding reinforcements of various forms and thicknesses.

[0131] According to another one of its aspects, the invention relates to a quite particular and advantageous method of manufacturing a boot, especially a sports boot. This method comprises:

- using the intermediate piece 15;

- assembling the latter, preferably by cementing, to the upper portion of the boot (upper/vamp); and

- fixing the rear half-sole 4 (or the front half-sole 3), preferably by cementing, on the intermediate piece 15 assembled to the upper portion of the boot (upper/vamp).

[0132] Still regarding the boot manufacture according to the invention, it must be noted that the sole having one or two half-soles can be used in a "strobel" type assembly method (upper peripherally sewn to a "strobel" sole), which makes it possible to avoid the need of a conventional insole which is more rigid and heavier, resulting in a significant weight loss.

[0133] In all of these sole and/or boot manufacturing methods, all types of conventional assemblies can be used: cementing, welding, duplicate molding, screwing, riveting.

[0134] According to another one of its objects, the present invention relates to a boot, especially a sports boot, having a sole 1 as defined hereinabove, or a sole 1 obtained by the aforementioned method.

[0135] The invention also relates to a boot such as defined in the previous paragraph, and which pertains to the group including:

- ski boot, in particular cross-country or telemark ski boot;
- cycling shoe;
- roller skate;
- ice skate;
- or any other sport requiring the coupling of a boot to a sports apparatus, such as rowing, water skiing, wakeboarding, surfing, snowboarding, ski surfing, climbing crampons.

[0136] Finally, the invention relates to the use of the sole 1 as described hereinabove, as such or as a product obtained by the method according to the invention, for the manufacture of a boot as described hereinabove.